

[0051] Metal portion 601 includes metal substrate 602 coated with abrasion-resistant coating 603, which corresponds to a composite coating that includes an intermediate porous oxide layer and an outer hard layer, such as abrasion-resistant coating 403 or 503, described above. Abrasion-resistant coating 603 can substantially cover all metal surfaces of metal substrate 602 which would be visible to a user when the electronic device is fully assembled—i.e., exterior surfaces of metal portion 601. In some cases, abrasion-resistant coating 603 covers at least some of the interior surfaces of metal portion 601—i.e., surfaces exposed within cavity 607. However, some interior surfaces of metal portion 601 within cavity 607 may not have abrasion-resistant coating 603.

[0052] Metal portion 601 can include a substantially planar (i.e., flat) back 608, curved sides 610 and openings 609 (e.g., speaker holes). Abrasion-resistant coating 603 can continuously cover surfaces of back 608, curved sides 610 and surfaces that define openings 609 to form a smooth, uninterrupted and cosmetically appealing protective coating to housing 600. Abrasion-resistant coating 603 has an outer hard layer that provides superior scratch resistance, and an intermediate layer that provides structural support for the hard layer, thereby making the abrasion-resistant coating 603 resistant to denting.

[0053] It should be noted that applications for the abrasion-resistant coatings described herein are not limited to enclosures, but can be used to coat any suitable device or part. For example, the coatings can be used to coat buttons (e.g., power or volume buttons of an electronic device), clasps and clips (e.g., for a watch), bands (e.g., watch bands or bracelets), jewelry, clothing accessories, etc.

[0054] FIG. 7 shows flowchart 700, which illustrates a process for forming an abrasion-resistant coating, in accordance with some embodiments. At 702 a surface of a metal substrate is optionally treated prior to an anodizing process. The pre-treatment can include one or more surface finishing operations, such as lapping (polishing), buffing, chemical polishing, chemical etching, and abrasive blasting. In some embodiments, a lapping process and/or chemical polishing process is used to form a mirror-finish on the surface of the metal substrate.

[0055] At 704, a portion of the metal substrate is converted to an oxide layer composed of a corresponding metal oxide material. In some embodiments, the metal substrate is an aluminum alloy and the oxide layer is composed of aluminum oxide. In some embodiments, a Type II anodizing process is used to form a porous oxide layer having pores with diameters ranging between about 10 and about 30 nanometers. The oxide layer can be grown to any suitable thickness. In some embodiments, the oxide layer is grown to a thickness ranging between about 8 to about 30 micrometers.

[0056] At 706, the oxide layer is optionally colored, such as by infusing a colorant within pores of the oxide layer. Any suitable colorant can be used, including one or more suitable dyes, pigments or metals. In some embodiments, one or more metals (e.g., tin, nickel, copper, cobalt) are electrodeposited within the pores to attain a black color to the oxide layer. At 708, a surface of the oxide layer is optionally lapped to a high gloss.

[0057] At 710, a hard layer is deposited on the oxide layer. The hard layer is composed of a material that has a greater hardness than the oxide layer. In some embodiments, the

hard layer is composed of a non-metallic and non-polymer material. In some embodiments, the hard layer is composed of a hard ceramic material. In some embodiments, the hard layer is composed of one or more of a carbide, a nitride, a diamond-like carbon, and a hard oxide. In a particular embodiment, the hard layer is composed of a DLC material.

[0058] The hard layer can be deposited to any suitable thickness. In some cases, the hard layer is significantly thinner than the oxide layer. In some embodiments, the hard layer is deposited to a thickness ranging between about 0.5 micrometers and about 3 micrometers. The thinner hard layer provides an outer hard surface that is resistant to scratching. The thicker oxide layer acts as a support that can prevent or reduce the occurrence of denting if the thinner hard layer. In embodiments where the oxide layer is colored, the oxide layer can also act as a color barrier such that if the hard layer does become scratched or dented, the colored oxide layer is visible rather than a bright metallic color of the underlying metal substrate. For example, a black-colored oxide layer can underlie a black DLC layer.

[0059] The foregoing description, for purposes of explanation, uses specific nomenclature to provide a thorough understanding of the described embodiments. However, it will be apparent to one skilled in the art that the specific details are not required in order to practice the described embodiments. Thus, the foregoing descriptions of the specific embodiments described herein are presented for purposes of illustration and description. They are not intended to be exhaustive or to limit the embodiments to the precise forms disclosed. It will be apparent to one of ordinary skill in the art that many modifications and variations are possible in view of the above teachings.

1. A housing for an electronic device, the housing comprising:

- a metal portion defining a cavity suitable for carrying internal electronic components; and
- an abrasion-resistant coating disposed on a metal surface of the metal portion, the abrasion-resistant coating including:
 - a hard layer characterized as having a first hardness, and
 - an intermediate layer grown from the metal portion and overlaid by the hard layer, the intermediate layer composed of a porous oxide and characterized as having a second hardness, wherein the first hardness is greater than the second hardness.

2. The housing of claim 1, wherein the hard layer is composed of at least one of a carbide, a nitride, or a diamond-like carbon.

3. The housing of claim 2, wherein the hard layer has a thickness ranging between about 0.5 micrometers and about 3 micrometers, and the intermediate layer has a thickness ranging between about 8 micrometers and about 30 micrometers.

4. The housing of claim 1, wherein the metal surface is curved.

5. The housing of claim 1, wherein the hard layer has an outer surface corresponding to an outer surface of the housing.

6. The housing of claim 1, wherein the porous oxide has pores with colorant infused therein.

7. The housing of claim 6, wherein the colorant includes tin, nickel, copper, cobalt or a combination thereof.